

MULTIMEDIA



UNIVERSITY

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STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

PEL 0016 – ELECTRICITY AND MAGNETISM

(All sections / Groups)

11 OCTOBER 2017
9.00 A.M – 11.00 A.M
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 3 printed pages excluding the cover page and the appendixes with FOUR (4) questions.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Answer **ALL** questions.

Question 1: (15 marks)

- a) In **Figure Q1.1** below, four parallel wires are placed one meter each from point P which is located at origin. It is found that the net magnetic field at the point P is directed towards the negative x-axis. All wires carry equal currents.

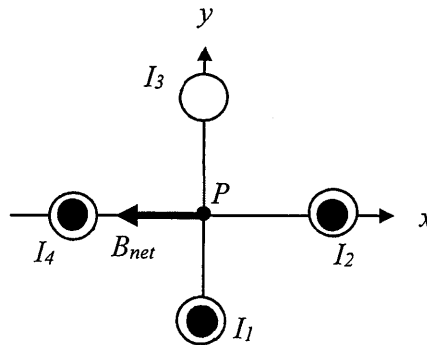


Figure Q1.1

- i) What is the direction of current in wire 3 ? Draw the direction of all the magnetic fields in the system at point P. Explain your answer. [4 marks]
 - ii) Calculate the magnitude of the current I_3 if the net magnetic field at point P is $18 \mu T$. [5 marks]
 - iii) A charge $Q = +18 \mu C$ moves across point P, in the direction of the magnetic field B_2 (due to current I_2), with a speed of $v = 18 \times 10^6 \text{ ms}^{-1}$. Determine the magnitude and direction of the net force, F_{net} acting on charge Q at point P. Draw all the directions of vectors (F_{net} , v and B_{net}) acting at point P. [3 marks]
- b) What is the direction of the current induced in the secondary loop (secondary circuit) immediately after the switch S_1 in **Figure Q1.2** is closed? Explain. Is there any changes in your answer if value of resistor R_1 suddenly decrease ? [3 marks]

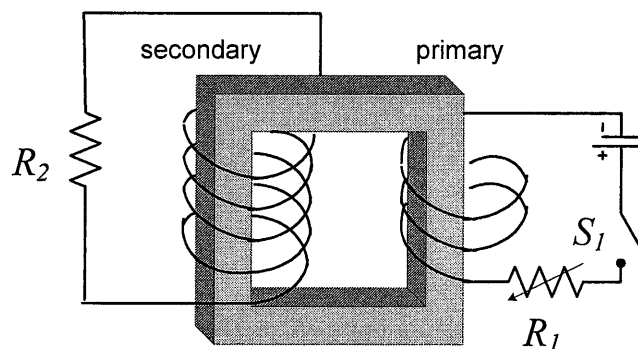


Figure Q1.2

Continued...

Question 2: (15 marks)

The circuit in **Figure Q2.1** contains $R_1 = 2 \text{ k}\Omega$, $R_2 = 4 \text{ k}\Omega$, $R_3 = 6 \text{ k}\Omega$ and $V_S = 12 \text{ V}$.

- Using Ohm's law, determine currents flowing through R_1 , R_2 and R_3 . [3 marks]
- Using voltage divider rule across resistor R_1 and R_2 , verify the answer of current which passes through these two resistors as calculated in (a). [Hint: Find voltage across R_2 , then find the current flowing in R_2] [2 marks]
- Using Kirchhoff's laws, find the current flowing in R_1 and R_2 and verify that it is similar to part (b). [2 marks]
- Repeat part (c), using Norton's theorem. Find and draw the Norton's equivalent circuit. [4 marks]
- Repeat part (c), using Thevenin's theorem. Find and draw the Thevenin's equivalent circuit. [4 marks]

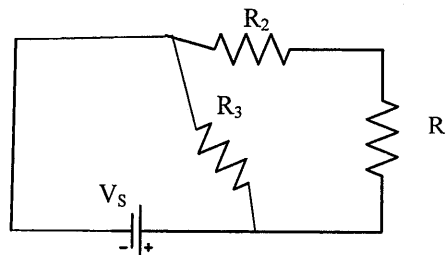


Figure Q2.1

Question 3: (10 marks)

A series *RCL* circuit has a $60.0 \text{ }\Omega$ resistor, a $40.0 \text{ }\mu\text{F}$ capacitor and a 50.0 mH inductor connected across an *ac* generator operating at 50.0 Hz and rms current of 0.12 A .

- Determine the reactance of inductor, X_L and the reactance of capacitor, X_C . [2 marks]
- Determine the impedance, Z of the whole circuit. [1 mark]
- From (b), determine voltage source, V_S . [1 mark]
- Sketch a phasor diagram showing reactance of inductor as well as capacitor, resistance and impedance of the circuit. [2 marks]
- Determine voltage across resistor (V_R), inductor (V_L) and capacitor (V_C). [3 marks]
- Using all values in (e), verify value of voltage source, V_S obtain in (c). [1 mark]

Continued...

Question 4: (10 marks)

- a) i. Sketch the difference in energy gap between conductor, insulator and semiconductor. Label accordingly. [3 marks]
- ii. Explain why there are free electrons exist in the conduction band of semiconductor material at room temperature (assume 300 K) but not for insulator. [2 marks]
- b) Determine I_B , I_C , V_{CE} , V_{BE} , and V_{BC} of the transistor circuit shown in **Figure Q4.1**. Assume the transistor is made of germanium semiconductor material. [5 marks]

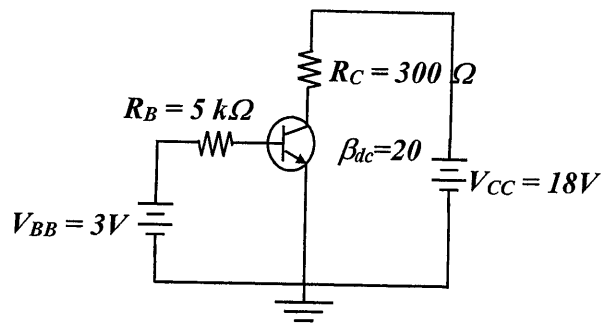


Figure Q4.1

End of Paper

APPENDIX I

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	$9.11 \times 10^{-31} \text{ kg}$
Proton mass,	m_p	$1.67 \times 10^{-27} \text{ kg}$
Elementary charge	e	$1.602 \times 10^{-19} \text{ C}$
Gravitational constant	G	$6.67 \times 10^{-11} \text{ N.m}^2/\text{kg}^2$
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_0	-13.6 eV
Boltzmann's constant	k_B	$1.38 \times 10^{-23} \text{ J/K}$
Compton wavelength	λ_c	$2.426 \times 10^{-12} \text{ m}$
Planck's constant	h	$6.626 \times 10^{-34} \text{ J.s}$
Speed of light in vacuum	c	$3.0 \times 10^8 \text{ m/s}$
Rydberg constant	R_H	$1.097 \times 10^7 \text{ m}^{-1}$
Acceleration due to gravity,	g	9.81 m/s^2
Atomic mass unit (1u)	u	$1.66 \times 10^{-27} \text{ kg}$
Avogadro's number	N_A	$6.023 \times 10^{23} \text{ mol}^{-1}$
Threshold of intensity of hearing	I_0	$1.0 \times 10^{-12} \text{ W/m}^2$
Coulomb constant	k	$8.988 \times 10^9 \text{ N.m}^2/\text{C}^2$
Permittivity of free space	ϵ_0/κ_0	$8.85 \times 10^{-12} \text{ C}^2/\text{N.m}^2$
Permeability of free space	μ_0	$4\pi \times 10^{-7} \text{ H/m}$

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc} + 1}$$

$$\beta_{dc} = \frac{\alpha_{dc}}{1 - \alpha_{dc}}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 nI$$

$$\xi = V + Ir$$

$$\xi = blv$$

$$\xi = -N \frac{\Delta\Phi}{\Delta t}$$

$$\xi = -L \frac{dI}{dt}$$

$$\xi = -M \frac{dI}{dt}$$

$$F = BIL \sin \theta$$

$$F = qvB \sin \theta$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$I_{\text{tot}} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I = neA(v_n + v_p)$$

$$I = nev_d A$$

$$I = I_{\text{max}} \sin \omega t$$

$$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}}$$

$$I_x = \left(\frac{R_T}{R_x} \right) I_T$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_0 N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_0 N_1 N_2 A}{l}$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$P_t = I_{\text{rms}} V_{\text{rms}} \cos \phi$$

$$P_r = V_{\text{rms}} I_{\text{rms}} \sin \phi$$

$$P_a = I_{\text{rms}}^2 Z$$

$$R = \frac{\rho L}{A}$$

$$R = R_0 [1 + \alpha(T - T_0)]$$

$$R_T = R_1 + R_2 + R_3 + \dots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

$$r = \frac{mv}{Bq}$$

$$\tau = NBIA \sin \theta$$

$$U = \frac{1}{2} LI^2$$

$$U = \frac{1}{2} B^2 A \frac{l}{\mu_0}$$

$$V_H = Bvd$$

$$V = V_{\text{max}} \sin \omega t$$

$$V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$$

$$V_x = \left(\frac{R_x}{R_T} \right) V_s$$

$$X_C = \frac{1}{2\pi f C}$$

$$X_L = 2\pi f L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\oint B \cdot dl = \mu_0 I$$

$$d\mathbf{B} = \frac{\mu_0 I}{4\pi} \frac{d\ell \times \hat{r}}{r^2}$$

$$\Phi_B = BA \cos \theta$$

$$\cos \phi = \frac{R}{Z}$$

$$\tan \phi = \frac{X_L - X_C}{R}$$